MARCH 18, 2021 | NEPOOL PARTICIPANTS COMMITTEE WORKING SESSION

Pathways to the Future Grid

Evaluating clean energy and carbon pricing frameworks as alternative market designs to advance the region's clean energy transition

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Pathways work will evaluate two potential market designs

- ISO is working with stakeholders and the Analysis Group to evaluate two market frameworks that have been discussed as potential pathways to the future grid
  - Forward clean energy market
  - Net carbon price
- The ISO plans to study both frameworks simultaneously and issue a final report in early 2022 that discusses the market impacts of both designs

Today's discussion focuses on key elements of each market design

- ISO offers preliminary straw frameworks associated with each market design for stakeholder consideration and discussion
- A straw approach provides one possible path for how each design could work for the purpose of conducting the quantitative modeling associated with the pathways work
- Welcome stakeholder feedback and concerns
- Comments can be provided either during committee discussions, or in writing to both Chris Geissler (cgeissler@iso-ne.com) and the Chair of the Participants Committee (or designee) for posting

Feedback on pathways designs received to date

- We appreciate the numerous written responses and comments received since the February meeting including
  - Advanced Energy Economy (and co-commenters)
  - Eversource
  - NESCOE
  - NRG
- Stakeholders have expressed views on various Forward Clean Energy Market (FCEM) design elements, including:
  - The set of resources that would receive clean energy certificates
  - Whether these certificates should be “static” or “dynamic”
  - The possibility of an integrated clearing of capacity and clean energy

Today's discussion seeks to be responsive to these stakeholder comments

- In putting forth a straw FCEM framework, we seek to respond to many of the comments stakeholders have raised on design elements, and help answer key questions outlined in the February presentation
- Included graphics on the straw FCEM framework slides to signal when topics in our presentation materials relate to those raised by stakeholders, providing additional opportunity for discussion
  - Colors signal the organization that commented; numbers reflect relevant slide or page number of stakeholder materials (if applicable)

AEE	Advanced Energy Economics	NES	NESCOE
EVS	Eversource	NRG	NRG

Detailed discussion of model mechanics and assumptions will occur at future meetings

- Once we have a clearer understanding of each of the designs to be modeled, we will be well equipped to discuss key modeling decisions, including:
  - Core model mechanics
  - Key input assumptions
  - Desired model outputs and analysis
- We look forward to engaging in further discussions about the modeling approach, inputs, outputs, and analysis in the coming months

ISO has published numerous memoranda for this meeting

- **FCEM scoping memo**: Provides more detail on a straw FCEM framework for stakeholder consideration and discussion
- **Evaluation of integrated clearing memo**: Discusses a theoretical auction framework that could allow for the joint procurement of capacity and clean energy
- **Net carbon price scoping memo**: Provides more detail on a straw net carbon price framework for stakeholder consideration and discussion
- Discuss contents from each of these memoranda in the slides that follow

STRAW FCEM FRAMEWORK: APPROACH AND PRODUCT DEFINITION

ISO raised numerous design questions at last stakeholder meeting

- These questions highlighted areas where the FCEM framework may not be fully developed yet and the ISO sought feedback to better understand certain design elements
- Questions indicated that there may be multiple approaches to various FCEM design details
- Feedback and observations that stakeholders raised at the February meeting helped to inform the straw FCEM framework it has put forth

Basis for ISO's straw FCEM framework

- Where the ISO did specify potential design elements, these were guided by three criteria:
  - Stakeholder feedback and preferences
  - Alignment with sound market design principles
  - Simplicity to model
- Anticipate that modeling will also consider alternate design elements, where specified by others and time permits
- ISO's presentation of a straw FCEM framework for purposes of study should not be construed as an ISO endorsement of any potential design

What resources are awarded clean energy certificates?

NES – 5

NRG - 3

- ISO proposes to evaluate effects of awarding clean energy certificates to resources that produce electricity without emitting carbon
- Includes: Wind, solar, hydro, nuclear
- In order to translate this straw framework into a more complete design, would need to determine more specific rules governing many other types of electricity generation including emerging technologies, etc.

Do storage resources receive clean energy certificates?

NES – 6

NRG - 4

- Storage can contribute to clean energy production by charging during off-peak hours (where the marginal resource may be clean) and discharging during on-peak hours (where the marginal resource is less likely to be clean)
- Stakeholders have expressed interest in ensuring that storage is compensated for its clean energy contributions
- The ISO is assessing whether it is sensible for such compensation to include clean energy certificates in addition to other wholesale market revenues
  - Storage may naturally see increased energy market revenues under an FCEM
  - Storage's participation via certificates does not always increase clean energy production in the region
- Welcome discussion and stakeholder feedback on this topic

Current straw framework presumes static certificates

NES – 6

AEE NRG - 4

- ISO proposes to evaluate static certificates, which do not vary with the emissions intensity of the marginal resource
- This static approach is simpler to model than a dynamic approach, which applies weights when awarding clean energy certificates
  - Weights are based on the carbon intensity of the marginal resource
- A dynamic approach is more complicated to design and model
  - How are these weights calculated? Are they determined before the applicable interval, or are they calculated in real-time?
- A dynamic approach may raise challenges for clean energy suppliers when offering into the FCEM and energy markets
  - If weights are not known when submitting FCEM and energy offers, participants have to formulate offers based on expected weights

NES – 6

NRG - 6

Straw framework procures a single clean energy product

- ISO proposes to evaluate a single clean energy product
- This approach may be simpler to model and requires the development of fewer demand parameters
- The use of a single product also promotes competition from all resources that can provide clean energy
- Using a single, broadly-defined product may therefore help to procure clean energy in a more cost-effective manner than if there were several different products

STRAW FCEM FRAMEWORK: SETTLEMENTS

NES – 6

NRG – 7, 9

Supplier settlements

- Resources that sell clean energy in the FCEM have two avenues to meet the obligation associated with this position
  - Produce clean energy during the delivery period and receive the corresponding clean energy certificates
  - Buy clean energy certificates from other resources that are willing to sell such credits (where they may expect to produce more clean energy than they sold forward)
- Because production of clean energy yields clean energy certificates that can meet a forward obligation or be sold, expect clean energy suppliers to lower their energy offer price to reflect the value of these certificates
  - Similar to how resources internalize the value of other environmental credits (i.e., RECs) in their energy offer price
- The assumption of a sensible spot market price is important for modeling as it leads to the cost-effective production of clean energy and facilitates realistic energy market offers

NES – 6

NRG – 8

Non-compliance penalty rate

- ISO proposes to include a non-compliance penalty rate to incent resources to provide the clean energy certificates sold forward
  - Any revenues collected due to clean energy certificate shortfalls would be rebated to load
- A higher rate will tend to reduce the likelihood that the region produces less clean energy than was sold forward, but it may also increase the price associated with clean energy certificates
  - Low penalty rate may produce modeling scenarios where demand for clean energy is not fully met through clean energy production
- ISO believes that this rate should be developed in close coordination with stakeholders and welcomes feedback on this design element

NRG – 13

Settlements to load

- ISO proposes to allocate the cost associated with the procurement of clean energy to Real-Time Load Obligation (RTLO) in the states that buy these environmental attributes
- Cost allocation follows a two step process:
- **Step 1**: Each state is allocated costs equal to the product of the forward clean energy price and the quantity of clean energy it procures
- **Step 2**: Allocate each state's costs to its RTLO over the applicable delivery period
- The FCEM scoping memo includes a numerical example walking through these steps in more detail

STRAW FCEM FRAMEWORK: INTERACTION WITH EXISTING STATE PROGRAMS

NES – 7

NRG – 11, 12

Interaction with existing state programs (RECs)

- Identify three potential approaches for stakeholder consideration
- **Approach 1**: Clean energy is a new environmental attribute that is distinct from other attributes (e.g., renewable)
- **Approach 2**: Clean energy certificates include all environmental attributes
- **Approach 3**: Existing state programs are discontinued with introduction of FCEM
- Each approach has different implications for the modeling efforts and how the region meets its environmental objectives in the future

NES – 7

NRG – 11, 12

Approach 1: Clean energy is separate attribute

- Under this approach, FCEM does not directly interact with existing state policies
- A wind resource would receive a clean energy certificate and a REC for each MWh of energy it produces
- Existing state programs such as RECs are assumed to continue, and would be considered in the modeling efforts

Approach 2: Clean energy includes all environmental attributes

NES – 7

NRG – 11, 12

- Clean energy certificates include all environmental attributes
- A wind resource that sells clean energy does not receive RECs or any other certificates (besides clean energy certificates)
- This approach requires further consideration of how clean energy certificates interact with other credits
  - How is demand for existing certificates impacted by the introduction of clean energy certificates?
  - Would suppliers potentially choose to forgo selling clean energy in order to receive RECs?
- Due to these interactions, this approach may be more complex to develop for the pathways modeling efforts

Approach 3: Existing state programs are discontinued with FCEM

NES – 7

NRG – 11, 12

- The FCEM replaces, rather than supplements, the existing programs as the mechanism by which the states pursue their environmental objectives
- A wind resource receives a clean energy certificate for each MWh of energy it produces and no other certificates
- Reduces the number of demand parameters that must be considered and modeled

Welcome stakeholder feedback on the preferred approach

NES – 7

NRG – 11, 12

- The approach taken here should be broadly consistent with that employed for the straw net carbon pricing framework
- In other words, both frameworks should either assume that the existing state programs are continued or discontinued
  - Will better allow for apples-to-apples comparisons between the frameworks
- To date, have heard some stakeholder support for approaches 1 and 2

POTENTIAL ICCM CONSTRUCT FOR PATHWAYS EFFORTS

AEE

NES – 7, 8

EVS

NRG – 15, 16, 17

Integration with FCM?

- ISO has identified an ICCM approach that appears to be conceptually feasible and can be used in the pathways modeling efforts
- Under this approach, resources would submit a single offer for two products – capacity and clean energy
- Auction would then jointly determine the capacity and clean energy awards that maximize social surplus, and specify separate prices for each product

Evaluation of an ICCM

- This presentation outlines a high-level concept for how such a market could function, but there are many outstanding questions that would need to be analyzed before a full market design could be developed
  - E.g., whether sensible pricing rules can be developed to consider non-rationable (lumpy) offers, implications for the FCA calendar, etc.
- The next few slides will consider a potential approach that does not consider these design details, but may serve as the basis of a framework for the Pathways work
  - Further discussion is available in the "Evaluation of an Integrated Forward Clean Energy Market" memo

Forward clean energy demand

- The FCM would be expanded so that, in addition to sloped MRI-based demand curves for capacity, it would include demand bids from states that reflect their willingness to buy clean energy forward
- The ICCM would thus procure two distinct products concurrently: (i) capacity and (ii) forward clean energy
- To meet demand for each product, supplier offers would include both capacity and clean energy components

ICCM offer structure

- Participants would submit a capacity offer, as in the FCM today, that includes both a maximum quantity and a price reflecting the minimum payment rate they would accept in selling capacity
- The ICCM would introduce a new clean-energy parameter to their offer that indicates how many MWh of forward clean energy it would sell per unit of CSO
  - E.g., a clean resource may specify that for each MW of capacity sold, it will also sell 100 MWh of clean energy forward
- A participant's offer price would then represent the minimum payment the participant would accept to take on a CSO *and* sell the associated bundled clean energy forward

Integrated auction clearing

- The ICCM would award capacity and clean energy positions to resources based on their offers and their contributions to meeting capacity and clean energy demand
- Much like with today's FCM, resources that offer these products at lower cost are more likely to be awarded positions than those that offer at higher prices
- However, the auction may award positions to a resource that submits a higher priced offer if this offer also includes clean energy
- Awards would be determined to maximize social surplus, where the social surplus considers the benefits of both products, as determined by the demand curves

POTENTIAL ICCM CONSTRUCT: NUMERICAL EXAMPLE

Numerical example: introduction

- The following numerical example represents a simple case illustrating how prices and awards might be determined when participants submit fully rationable offers
- For more details on how participants determine their offers and how prices are set given rationability, please see the corresponding “Evaluation of an Integrated Forward Clean Energy Market” memo

Numerical example: supply and demand parameters

Table 1. Resource Parameters

Generator	Max Capacity	Clean Energy Parameter	Offer
Non-Clean 1	500 MW	-	$60,000/MW
Non-Clean 2	500 MW	-	$70,000/MW
Clean 1	300 MW	6000 MWh/MW	$150,000/MW
Clean 2	300 MW	7000 MWh/MW	$200,000/MW

- For simplicity, assume vertical demand curves for both capacity and clean energy
- Capacity demand = 850 MW
- Clean energy demand = 2,500,000 MWh

Numerical example: clearing and awards

Table 2. ICCM Clearing and Awards			
Generator	Offer	Capacity Award	Clean Energy Award
Non-Clean 1	$60,000/MW	450 MW	0 MWh
Non-Clean 2	$70,000/MW	0 MW	0 MWh
Clean 1	$150,000/MW	300 MW	1,800,000 MWh
Clean 2	$200,000/MW	100 MW	700,000 MWh

- The auction awards capacity positions to Non-Clean 1, and capacity and clean energy positions to Clean 1 and Clean 2

Numerical example: determination of prices

- In this example, prices are set for each product using the marginal resource
- Price for capacity is $60,000/MW, where Non-Clean 1 is the marginal resource with respect to capacity
  - $60,000 is the incremental cost associated with a 1 MW increase in capacity demand
- Price for clean energy is $20/MWh, where Clean 2 is the marginal resource with respect to clean energy
  - $20 is the incremental cost associated with a 1 MWh increase in clean energy demand
  - This cost results from a modest increase in Clean 2's capacity award, and a corresponding decrease in Non-Clean 1's capacity award so that total clean energy sold increases and capacity is unchanged

Numerical example: resource compensation

Table 3. Resource Specific Clearing Prices					
			Non-Clean 1	Clean 1	Clean 2
[1]	CSO Clearing Price		$60,000/MW	$60,000/MW	$60,000/MW
[2]	Clean Energy Parameter		0 MWh/MW	6000 MWh/MW	7000 MWh/MW
[3]	Forward Clean Energy Price		$20/MWh	$20/MWh	$20/MWh
[4]	Resource Price Per MW	=[1]+[2]*[3]	$60,000/MW	$180,000/MW	$200,000/MW

- Each resource's total compensation per MW of capacity sold is equal to capacity clearing price ($60,000/MW) plus the product of the clean energy parameter and the forward clean energy price ($20/MWh)

Key observations

- There are two prices for the procured products – one for capacity in $/MW and one for clean energy in $/MWh – to account for the two distinct products procured
- The optimization may award capacity to a higher priced resource instead of a lower priced resource because the higher priced resource also offers clean energy
  - For example, Non-Clean 2 does not receive an award while Clean 1 and Clean 2 both do receive awards
- Resources will receive different payment rates per unit of capacity sold to reflect varying quantities of clean energy sold
  - E.g., Clean 2 receives a higher payment rate than Clean 1 to reflect that it sells more clean energy per unit of capacity

ICCM construct represents a high level framework for modelling

- The numerical example above includes fully rationable offers. Incorporating non-rationable offers may raise challenging issues that have not yet been evaluated
- At present, the ISO has not evaluated the challenges that may arise when translating this conceptual framework into a more fully developed market design
  - The ICCM would likely add significant complexity to the FCM and would require a number of substantial changes to the FCM rules, schedule, and processes
- Stakeholder feedback on this element of the framework design and potential alternatives the ISO should explore are most welcome

STRAW NET CARBON PRICING FRAMEWORK FOR STAKEHOLDER CONSIDERATION

ISO provided overview of net carbon pricing framework at Feb. stakeholder meeting

- There are outstanding design questions about this framework relating to various components, including:
  - Cost allocation
  - Interaction with existing state programs
- Welcome continued stakeholder feedback on the straw net carbon pricing framework

Basis for ISO's straw net carbon pricing framework

- Where the ISO did put forth specific design elements, these were guided by three criteria:
  - Aligns with sound market design principles and allows the region to decarbonize its electricity sector cost-effectively
  - Simplicity to model
  - Where possible, choose design elements that are consistent with those in the FCEM framework to better allow for apples-to-apples comparisons
- Anticipate that modeling will also consider alternate design elements, where specified by others and time permits
- ISO's presentation of a straw net carbon pricing framework for purposes of study should not be construed as an ISO endorsement of any potential design

Product is carbon emissions

- Resources are charged a carbon price for each unit of carbon emitted to produce electricity
- Such a construct is already in place in the region, as each state participates in the Regional Greenhouse Gas Initiative (RGGI)
  - A net carbon price is likely to be significantly higher than that associated with RGGI, and therefore further drive the region's decarbonization
- In practice, design could use a fixed carbon price, which allows the emissions quantity to float, or a cap-and-trade approach, which fixes the quantity of emissions and allows the price associated with carbon to float
  - These approaches may have different practical implications
  - The modeling efforts are likely to be applicable to both approaches, so it does not appear necessary to choose between them in developing the straw framework

Supplier settlements

- Suppliers incur a cost for each unit of carbon emitted in electricity production
- Carbon-emitting suppliers will increase their energy offer price by the product of the carbon price and the intensity of their carbon emissions to cover these costs
- This has two important implications that will be reflected in the modeling:
  - May reshuffle supply stack to make lower emitting resources more likely to produce electricity
  - Increases energy market revenues for lower emitting resources that emit less carbon than the marginal resource, which will help region transition to lower emissions resources

Settlements to load

- ISO proposes that the revenue collected from a net carbon price would be rebated to all RTLO for the region
  - Under this approach, this rebate would not vary between states
- The per MWh rebate will be equal to the product of the applicable carbon price and the average carbon intensity of electricity production for the delivery period

Interactions with existing state environmental programs

- Identify two potential approaches:
- **Approach 1**: Existing state programs continue with the net carbon price
- **Approach 2**: The net carbon price replaces the existing state programs
- For consistency, the approach should be consistent with that assumed in the straw FCEM framework
  - In other words, if the straw FCEM framework assumes that existing state environmental programs are continued, the straw net carbon price framework should as well

ISO looks forward to working with stakeholders to evaluate Pathways to the Future Grid

- With help of stakeholders and the Analysis Group, ISO will evaluate market outcomes under forward clean energy market and net carbon pricing frameworks
- Welcome stakeholder feedback on these efforts, including the two frameworks to be studied
- Look forward to discussing the modeling approach at future stakeholder meetings
- Share final report on modeled market outcomes with stakeholders in February 2022